

The World Energy Data Sheet Reference Guide

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The World Resources Inventory

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WORLD ENERGY DATA SHEET: NOTES AND CALCULATIONS

The World Energy Data Sheet quantifies information on total energy use, petroleum supplies, other depletable energy supplies, electricity production, and renewable energy resources for each country of the world. A comparison between different countries or different energy sources can readily be undertaken with the data sheet.

To help make the data sheet clearer, abbreviations used for country names as well as specific notes about the data for countries are included. To clarify the data columns on the data sheet, the titles, notes on definitions and usefulness of the columns, sources of all information, and calculations employed to derive the data are detailed below.

COUNTRIES OF THE WORLD

Abbreviations:

Cent. Afr. Rep.	Central African Republic
Eq. Guinea	Equatorial Guinea
N/C America	North and Central America
Dominican Rep.	Dominican Republic
USA	United States of America
Kampuchea DM	Democratic Kampuchea (Cambodia)
Korea DPR	Democratic People's Republic of Korea (North)
Korea Rep.	Republic of Korea (South)
Lao PDR	People's Democratic Republic of Laos (Laos)
Yemen AR	Arab Republic of Yemen
USSR	Union of Soviet Socialist Republics
Belgium-Luxem.	Belgium-Luxembourg
German DR	German Democratic Republic (East)
Germany, FR	Federal Republic of Germany (West)
Papua-N. Guin.	Papua-New Guinea

Notes:

1. The list of countries and continental subdivisions employed is derived from the Food and Agricultural Organization of the United Nations. The countries are autonomous or semi-autonomous states and have a population of at least 200,000 people. Countries and regions not listed are included (when data is available) in continental and world totals. Therefore the totals do not necessarily correspond to the sum of the listed countries.

2. The U.N. includes Botswana, Lesotho, Namibia and Swaziland with South Africa, and therefore no data is available in those countries for the columns containing U.N. information.

DATA COLUMNS

- Title:** Population--1980 (Millions)
Notes: Population estimates for mid-1980
Sources: All data from reference 1.
- Title:** Total Land Area--1977 (1000 Hectares)
Notes: Total land area includes the area of inland water bodies.
Sources: All data from reference 2.
- Title:** Total Commercial Energy Production--1978 (Billion kWh/yr)
Notes: Commercial energy includes: solid fuels, crude petroleum, natural gas liquids, natural gas and hydro- and nuclear-generated electricity. Only production of primary energy forms is included (no refined petroleum, synthetic fuels, coke oven gas, etc. are included).
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 0.2778 thousand terajoules
- Title:** Total Commercial Energy Consumption--1978 (Billion kWh/yr)
Notes: Consumption data is based on the difference between production, trade and stock variation data. Consumption of commercial forms of energy in the conversion to other forms of energy is not included in total consumption as this would be counting this energy twice.
Sources: All data and conversion factors from reference 3.
Calculations: (For conversion factor from U.N. figures.) Billion kWh = 0.2778 thousand terajoules (terajoules = 10^{12} joules; 1 joule = 278×10^{-6} kWh; 129 calories = 948×10^{-3} BTU)
- Title:** Total Commercial Energy Consumption Per Capita--1978 (kWh per capita/yr)
Notes: Total commercial energy consumption divided by United Nations--1978 population estimates.
Sources: All data and conversion factors from reference 3.
Calculations: kWh per capita = 0.2778 megajoules per capita.
- Title:** Total Commercial Energy Consumption Per Capita Per Quality of Life Index--1978 (kWh per capita per PQLI/yr)
Notes: The Physical Quality of Life Index (PQLI) was developed by the Overseas Development Council, Washington, D.C., in response to the need for a non-income measure that summarizes the many aspects of human well-being. It combines three indicators--infant mortality, life expectancy at age one, and literacy--into a single composite index. The index runs from 0 to 100, 0 being the lowest level of well-being and 100 being the highest. For a more detailed description of the nature and uses of the PQLI, contact the Overseas Development Council, 1217 Massachusetts Avenue, NW, Washington, DC 20036. A comparison of per capita energy consumption and physical quality of life index give a qualitative understanding of a country's ability to use energy to improve its living condition.
Sources: Energy data and conversion factors from reference 3.
Calculations: Physical quality of life data from reference 4.
 kWh per capita = 0.2778 megajoules per capita.
- Title:** Crude Petroleum Production--1978 (Billion kWh/yr)
Notes: Crude petroleum comprises the liquid product of both land and offshore oil wells. Data for crude petroleum include shale oil and field or lease condensate but exclude natural gas liquids and oils obtained from the distillation of solid fuels.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh/yr = 11.960 million metric tons--oil equivalent.
- Title:** Refinery Capacity--1978 (Billion kWh/yr)
Notes: Refinery capacity refers to petroleum refinery distillation capacity, the theoretical maximum capability of all crude distillation plants available for operation at the end of the year stated. Reserve plants are included, whether or not they are in actual operation at the time.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 11.960 million metric tons--oil equivalent.
- Title:** Refinery Output--1978 (Billion kWh/yr)
Notes: Refinery output comprises the production of energy petroleum products and non-energy petroleum products.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 11.960 million metric tons--oil equivalent.

10. Title: Energy Petroleum Products--Production--1978 (Billion kWh/yr)
Notes: Energy petroleum products include: liquidated petroleum gas, aviation gasoline, motor gasoline, kerosene, jet fuel, and fuel oils. Non-energy petroleum includes: naphtha, white spirit, paraffin wax, lubricating oils, bitumen and petroleum coke.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 11,960 million metric tons--oil equivalent.
11. Title: Energy Petroleum Products--Apparent Consumption--1978 (Billion kWh/yr)
Notes: Apparent consumption data is based on the difference between production, trade and stock variation data.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 11,960 million metric tons--oil equivalent.
12. Title: Total Gasoline Production--1978 (Billion kWh/yr)
Notes: The major portion of the gasoline refined in most countries is consumed as motor gasoline within its boundaries (except for some of OPEC).
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 13,099 million metric tons--gasoline.
13. Title: Solid Fuels Production--1978 (Billion kWh/yr)
Notes: Solid fuels production is comprised of the following primary energy forms: coal (all grades of anthracite and bituminous), lignite (including peat where significant quantities can be identified) and brown coal. All primary fuels are reduced from a ton-fuel-ton basis to a common coal equivalency of 7,000 calories/gram.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 8,136 million metric tons--coal equivalent.
14. Title: Solid Fuels Consumption--1978 (Billion kWh/yr)
Notes: Consumption of solid fuels includes secondary solid fuel consumption (hard coal briquettes, coke oven coke, gas coke, lignite and peat briquettes and brown coal coke) and primary solid fuel consumption not used in the conversion to secondary fuels.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 8,136 million metric tons--coal equivalent.
15. Title: Natural Gas Production--1978 (Billion kWh/yr)
Notes: Natural gases comprise any combustible gas of natural origin from underground sources, consisting primarily of hydrocarbons. Production data includes any gas obtained from gas fields, petroleum fields or coal mines actually collected and utilized as a fuel or raw material. Data thus excludes gas used for pressurizing and reinjection, as well as gas flared, vented or otherwise wasted.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 1,162 thousand teracalories.
16. Title: Natural Gas--Apparent Consumption--1978 (Billion kWh/yr)
Notes: Consumption of natural gas is based upon the difference between production, trade and stock variations. Manufactured gases (coke oven gas, gas work gas, and refinery gas) are not included in these consumption figures although they supply the same energy network.
Sources: All data and conversion factors from reference 3.
Calculations: Billion kWh = 1,162 thousand teracalories.
17. Title: Uranium Production--1977 (Billion kWh/yr)
Notes: The data is based on the energy content of the uranium mined. The amount available for nuclear electricity generation is significantly smaller.
Sources: All data from reference 3. All conversion factors from reference 5.
Calculations: Billion kWh = 22.04 metric tons--U content.
18. Title: Total Installed Capacity of Electrical Generating Plants--1978 (1000 kilowatts)
Notes: Installed electrical capacity comprises the sum of the main and auxiliary generators in all groups, including standby groups.
Sources: All data from reference 3.

19. Title: Total Electricity Production--1978 (Billion kWh/yr)
Notes: Production of electric generating plants comprises the total gross production of electricity generated by public utilities for use in the public sector and by industrial establishments generating for their own use or for sale. Output is measured at generating centers, and therefore usually includes station use and transmission loss. World electricity exchange and storage are small, thus total electricity consumption closely parallels total electricity production for most countries.
Sources: All data from reference 1.
20. Title: Thermal Generated Electricity Production--1978 (Billion kWh/yr)
Notes: Electricity generated from the thermal combustion of fossil fuels.
Sources: All data from reference 3.
21. Title: Hydro Generated Electricity Production--1978 (Billion kWh/yr)
Notes: Electricity generated from falling water.
Sources: All data from reference 3.
22. Title: Nuclear Generated Electricity Production--1978 (Billion kWh/yr)
Notes: Electricity generated from nuclear fission reactions.
Sources: All data from reference 3.
23. Title: Geothermal Generated Electricity Production--1978 (Billion kWh/yr)
Notes: Electricity generated from geothermal heat reservoirs (primarily from underground steam).
Sources: All data from reference 3. This data is only present on the computer tape version of this source.
24. Title: Geothermal Energy from 5 Km Below Ground (Million kWh)
Notes: The potential geothermal energy contained in the hot dry rock from the surface down to 5 Km below the ground is quantified for each country. This low-grade energy is regenerated via heat flow from the center of the Earth. The data refers to the amount of energy available to produce electricity. Heat can be utilized as well.
Sources: Country area data from reference 2. Heat flow data from reference 6. Heat flow--potential energy conversion factors--from reference 7.
Calculations: 1. Integrate Lee and Oyeda heat flow data (reference 6) to obtain the average value for each country.
2. Convert heat flow data to temperatures at 5 Km underground. Using Fig. 2,214 of the Futures Group's study (reference 7), a linear relationship between heat flow values (HFU) and underground temperature (T) can be derived:
$$T(^{\circ}\text{C}) = 90(^{\circ}\text{C} - \text{cm}^2/\text{microcal}) * \text{HFU} (\text{microcal}/\text{cm}^2) + 14, (1)$$

3. Convert temperature data to potential geothermal energy using conversions in reference 7, Fig. 2,214. Using an area (A) of 4 by 5 miles or 20 square miles (5,180 thousand hectares) and a temperature drop (TC) from 290 to 90°C (or a 200°C drop) gives a potential geothermal energy (GE) of 6.8×10^{19} BTU (19.9×10^{17} kWh). Since
$$GE = K * A * TC, (2)$$

and:
$$K = GE/A/TC, (3)$$

therefore: $K = 19.9 \times 10^{17} \text{ kWh}/1000 \text{ ha}/^{\circ}\text{C}$. Therefore the potential geothermal energy can be found by calculating the underground temperature (T) from available heat flow data, inserted into Equation 1 and inserting the result into Equation 4:
$$GE (\text{kWh}) = 19.9 \times 10^{17} (\text{kWh}/1000 \text{ ha}/^{\circ}\text{C}) * A (1000 \text{ ha}) * [T - 90] (^{\circ}\text{C}), (4)$$

25. Title: Solar Energy Striking the Surface (1000 Billion kWh/yr)
Notes: The total amount of solar radiation (direct and diffuse) incident upon a horizontal surface at ground level is quantified for each country. This energy is available for either heat or electricity production.

Sources: Country area data from reference 2. Insolation data from reference 8.

Calculations: 1. Average insolation data for the four months given to obtain averaged yearly data. Integrate averaged data for year to determine average insolation (I) for each country.

2. Multiply this average insolation (I) by each country's area (A) to determine the solar energy striking the surface for each country via Equation 6:

$$SE \text{ (kWh/yr)} = A(1000 \text{ ha}) \times I(\text{cal/cm}^2/\text{day}) \times 4.241 \times 10^6 \text{ (kWh} \cdot \text{days}^{-1} \cdot \text{cm}^2/\text{cal/year/1000 ha)} \quad (5)$$

26. Title: Wind Energy Near Ground Level (8.116 Billion kWh/yr)
Notes: The energy present in the average, near-ground level, horizontal windstream is quantified for each country. The maximum utilization of windpower is limited by both mechanical efficiency and a minimum required wind machine separation of six rotor diameters to prevent interference. Wind energy near ground level is depleted after being tapped by windstreams from above.

Sources: Country area data from reference 2. Wind data and equations from reference 9. Page numbers in the early editions will refer to reference 8.

Calculations: 1. Shaft horsepower vs. Rotor Diameter and Wind Speed (p. 64). Shaft horsepower can be extrapolated for a 300-foot rotor diameter and a wind speed of 25 miles per hour. Under these conditions:

$$\text{Power (P)} = 3318 \text{ (hp)} = 7475 \text{ (kw)} \quad (6)$$

2. A horizontal wind rotor requires a spaced (%) of at least six rotor diameters to prevent interactions of the rotors. Therefore, a wind rotor with a 300-foot diameter requires:

$$S = (6 \times 300 \text{ ft})^2 = 3.24 \times 10^6 \text{ (ft}^2\text{)} = 30.116 \text{ (ha)} \quad (7)$$

3. Annual Availability of Wind Energy in Different Parts of the World (p. 46). The estimated amount of wind energy in kWh per year per rated kw output for wind machines designed for wind speeds of 25 mph, for all land masses is detailed. Integrate the above data to determine the average annual availability (AAA) of wind energy for each country.

4. The obtainable wind energy (OWE) can be determined by multiplying the average annual availability (AAA) by the number of wind rotors [land area (A) divided by the area per wind rotor (S)] and then multiply by the power (P) of each wind machine via Equation 8:

$$\text{OWE (kWh/yr)} = \text{AAA (kWh/yr/kw)} \times P \text{ (kw)} \times A \text{ (ha)} / S \text{ (ha)} \quad (8)$$

5. The wind rotor rated at 2475 kw occupies 30.116 ha and therefore removes energy from the windstream at the rate of 0.764 watts per square foot. A 25 mph wind actually has an energy density of 79.6 watts per square foot. Therefore, the wind machine only removes energy at a 0.764/79.6 or 0.00993 efficiency (e). Thus, the total wind energy (WE) present in each country can be determined by dividing the obtainable wind energy (OWE) by the removal efficiency (e) via Equation 9:

$$\text{WE (kWh/yr)} = \text{OWE (kWh/yr)} / e \quad (9)$$

By substituting Equation 8 into Equation 9 and employing the determined values of P, S, and e, the wind energy (WE) present in the horizontal windstream for each country can be determined from available data:

$$\text{WE (kWh/yr)} = 8563.7 \text{ (kw/ha)} \times \text{AAA (kWh/yr)} \times A \text{ (ha)} \quad (10)$$

27. Title: Biomass Energy From Residues (Billion kWh/yr)
Notes: The energy content of crop residues (the portion not useful as food or other products) plus the energy content of human and domestic excretion is quantified for each country. Anaerobic digestion techniques

can convert about 60% of the biomass energy into useful methane gas, while pyrolysis techniques can convert more than 80% of this energy into useful methane. Direct burning of the residues is very inefficient. Crops included: cereals, roots and tubers, vegetables, melons, fruits, and pulses. Domestic animals included: horses, mules, asses, cattle, pigs, sheep, goats, chickens, ducks, and turkeys. Human population, domestic animal and crop production data from reference 2. Crop residue coefficients, manure production data and moisture content of manure data from reference 10. Energy value of crop residue and energy value of manure data from reference 11.

Calculations: 1. The energy content of crop residues (CRE) for each country can be determined by multiplying the amount of each crop produced (CP) by the crop residue coefficient (CRC) and then by the energy value of the crop residue (EVR) and then summing for every crop:

$$\text{CRE (kWh/yr)} = \sum (\text{CP (mt/yr)} \times \text{CRC} \times \text{EVR (kWh/mt)}) \quad (11)$$

2. The required crop residue data is:

$$\text{Crop (CP)} \quad \text{Crop Residue Coefficient (CRC)} \quad (12)$$

Cereals	1.70
Roots & Tubers	0.20
Vegetables & Melons	0.25
Fruit (excl. Melons)	0.25
Pulses	2.00

$$\text{Energy Value of Crop Residues (EVR)} = 12.5 \times 10^6 \text{ Btu/ton} = 455 \text{ kWh/mt} \quad (13)$$

3. The energy content of manure (ME) for each country can be determined by multiplying the number of head of each domestic animal (DA) by the amount of manure produced (MP) per head, by the solid content or by 1 - moisture content (MC) of the manure and then by the energy value of the manure (EVM), and summing for every domestic animal:

$$\text{ME (kWh/yr)} = \text{DA (head)} \times \text{MP (mt/head/yr)} \times [1 - \text{MC}] \times \text{EVM (kWh/mt)} \quad (14)$$

4. The required manure data is:

Domestic Animal (DA)	Fresh Manure Production Assumed	Moisture per Head (MP) in kg/yr	Contents (MC) (%)
Horses, Mules, Asses	2700	80	80
Cattle	5400	80	80
Pigs	1500	80	80
Sheep, Goats	500	70	70
Chicken, Ducks, & Turkeys	13	60	60
Human (feces only)	75	75	75
Human (urine only)	21.5 (dry solids)		

$$\text{Energy Value of Manure (EVM)} = 14 \times 10^6 \text{ Btu/ton} = 455 \text{ kWh/mt} \quad (16)$$

5. The biomass energy (BE) from residues for each country can be calculated by adding together the crop residue energy (CRE) for each crop and the manure energy (ME) for each domestic animal:

28. Title: Fuelwood and Charcoal Production--1978 (Billion kWh/yr)
Notes: Total production for fuelwood and charcoal includes coniferous and non-coniferous woods. Most of the production is consumed locally.

Sources: All production data from reference 3. Fuelwood conversion factors from reference 5. Charcoal conversion factors from reference 12.

Calculations: Fuelwood: Billion kWh = 1.672 million cubic meters
Charcoal: Billion kWh = 8.895 million metric tons

29. Title: Wave Energy Near Coastlines (Billion kWh/yr)
Notes: The amount of energy available in sea waves near coastlines is quantified for each country that has a sea coast. Wave energy is regenerated by the wind and can be tapped at intervals upon the ocean. This is not accounted for in the present wave energy estimate. In addition, wave energy is present in the mid-ocean, away from coastlines. Coastline data from reference 13. Specific wave energy density data from references 14 and 15. General wave energy density data from Dr. C.M. Pleass, College of Marine Studies, University of Delaware, personal communication.

Calculations: 1. The general wave energy density for unspecified areas is 5 kw per meter of coastline or approximately 45 Mw per meter (10⁶ ft) wide.
2. The available wave energy (AW) near coastlines for feasible countries can be calculated by multiplying the general wave energy density (AWD), either specific or general, by the coastline length (L):

$$AW = (kW/m) \times L \quad (17)$$

$$AWD (Mw/meter) \times L (km) \times 10^6 = AW (Mw) \quad (17)$$

30. Title: Tidal Energy From Large Sites (Billion kW/yr)
Notes: Available tidal energy from large sites that have been studied is quantified for some countries. Tidal energy can be tapped at any large water body's shore, although most of these sites have not been quantified to date.
Sources: All data from reference 16.

31. Title: Draft Animal Physical Work Energy--1977 (Billion kW/yr)
Notes: The energy available from the physical labor of the entire draft animal population working 365 days per year is quantified for each country. Draft animals include horses, mules, asses, cattle, buffalo, and camels.
Sources: Draft animal population data from reference 2. Draft animal work rate potential data and work day from reference 20.

Calculations: 1. The available draft animal work energy (DAW) can be calculated by multiplying the number of head of draft animals (DA) by the draft animal work potential (DAWP) and then by the amount of time worked. This can be calculated by multiplying the draft animal work day (DAWD) by the number of days in a year. Therefore:

$$DAW (kW/yr) =$$

$$DA (head) \times DAWP (kW/head) \times DAWD (days/day) \times$$

$$365 (days/yr) \quad (18)$$

2. The required draft animal work data is:

$$DAWP = 0.6 (hp) = 0.45 (kW/head) \quad (19)$$

$$DAWD = 10 (hours/day) \quad (20)$$

32. Title: Human Physical Work Energy--1977 (Billion kW/yr)
Notes: The energy available from the physical labor of the economically active population working 30 hours per day, 365 days per year, is quantified for each country. The economically active population is defined as all persons engaged or seeking employment in an economic activity, whether as employers, own-account workers, salaried employees or unpaid workers assisting in the operation of a family farm or business.
Sources: Economically active population data from reference 2. Human work data from reference 17.

Calculations: 1. The available human work energy (HWE) can be calculated by multiplying the economically active population (EA) by the human work potential (HWP) and then by 365 (days/yr). Therefore:

$$HWE (kW/yr) =$$

$$EA (people) \times HWP (kW/person/day) \times 365 (days/yr) \quad (21)$$

2. The required human work data for a 20-hour day is:

$$HWP = 225,000 (ft-lbs/day) = 7,000 (kW/day) \quad (22)$$

THE WORLD ENERGY SOURCE SUMMARY

The World Energy Source Summary has been revised and updated from Energy, Earth and Everyone by McIrd (ed) (Anchor Press/Doubleday). Unless a specific reference is noted, all data is from the above source. The summary goes beyond either the detailing of production, consumption, or total potential availability of energy sources, or the mapping of certain aspects of these energy sources, and accounts for technological and economic effects upon the energy system. The summary is useful in the setting of boundaries for the overall availability of various energy sources as well as the time frames within which they can be of significance.

ENERGY SOURCE NOTES

Geothermal energy and nuclear fusion energy are actually depletable energy sources, but their present life expectancy is of such order as to render them indistinguishable from renewable energy sources. Electrostatic energy is the energy stored in the atmosphere as electricity and released as lightning. Conservation is not an actual energy source, but rather a technique that supplies additional energy for end uses.

DATA COLUMN

Column 1 details the current yearly production of each energy source in their traditional, given units of measurement. Column 2, the current yearly production in trillion kW equivalents; Column 3, the ultimately recoverable reserves, i.e., the total amount of the given resource estimated to exist on Earth, in given units; Column 4, the ultimately recoverable reserves in trillion kW equivalents; Column 5, the total known or proved reserves, i.e., the amount that has been discovered and can be obtained with current technology, in given units; Column 6, the total proved reserves in trillion kW equivalents; Column 7, the economically recoverable reserves (a smaller fraction of the proved reserves), in given units; Column 8, the economically recoverable reserves, in trillion kW equivalents; Column 9, the present life expectancy of the given reserves at projected use rates; Column 10, the present ultimate potential available from the renewable energy sources that is available each year; Column 11, the yearly amount of the energy that could be harnessed with present-day knowledge in ten years of intense development, given the resource commitments outlined in Part 4 of Energy, Earth and Everyone are carried out. Columns 12 and 13 extend this development to 20 years and 50 years, respectively. Columns 14 and 15 list the largest and smallest size power plants that humanity has been able to produce and operate successfully that utilize their respective energy source. They help illustrate the limits of current technology for each energy source. Column 16 lists the current planning, implementation and construction time of power plants; Column 17, the present life span of a given power facility; Column 18, the capital costs (cost of construction of the power plant, not of the operation) in terms of dollars per installed kilowatt; Column 19, the costs of the energy delivered (includes the capital costs and the cost of operation) in terms of mills per kW; and Column 20, the delivered energy cost in dollars per million Btu.

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WORLD ENERGY SOURCE SUMMARY NOTES AND REFERENCES

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4. This number is strictly a "ball park" estimate. It assumes a world total of 15,000 solar-heated houses (12,000 in U.S.), 2.5 million solar hot water heaters and 200 industrial solar energy applications. Hot water heaters are assumed to produce 10 kWh per day of energy, solar-heated houses and industrial solar applications 30 kWh per day. These figures do not take into account any of the work done for humanity by the sun in growing our food, heating our atmosphere, drying our clothes on the clothesline, etc. It only attempts to count the solar energy that is used consciously or volitionally by humanity. For a more thorough discussion on the limitations of this number, see Baer, S., "The Clothesline Paradox," Colvolution Quarterly, Winter 1975.
5. 1977 worldwide sales of photovoltaic cells, 750 kw; cumulative sales are about 2 Mw. 2 Mw installed capacity operating 30% of the time = 5.25 million kWh.
6. Estimate, based on 500,000 windmills (350,000 in U.S., 300,000 pumping, 50,000 electric, Duff, R.C., Energy, Resources and Policy, Addison-Wesley Publishing, Reading, Mass., 1978, p. 22), average size 3 kw, operating 50% of the time, and three 2 Mw power plants operating 60% of the time.
7. Based on 7 million biogas facilities operating in China, each producing 10 million BTU/yr (5ml, V., "China's Energetics: A System Analysis" in Chinese Economy Post-Map, A compendium of papers submitted to the Joint Economics Committee, Congress of the U.S., U.S. Government Printing Office, Nov. 9, 1978); 50,000 biogas facilities in India (Hayes, D., Rays of Hope: The Transition to a Post Petroleum World, W.W. Norton, New York, 1977, p. 195; and Metz, W.D., and A.L. Hammond, Solar Energy in America, AAAS, 1978, p. 106), each producing 3,600 million BTU/yr (from A. Makhlajani and A. Poole, Energy and Agriculture in the Third World, Ballinger Publishing, Cambridge, Mass., 1975, charts 4-6, p. 109); and 1.5 billion liters of alcohol production in the U.S. and Brazil produced for gasoline mixtures (Gabel, M., Energy, Earth and Everyone, Anchor Press/Doubleday, Garden City, New York, 1980) at 5.61 Kcal/m³. This estimate of bio-conversion energy does not include production from smaller scale projects in other parts of the world, nor does it include the added savings from the fertilizer produced at the biogas facilities.
8. Based on 20 million BTU/cord of wood and 128 ft³ per cord (Shelton, J., The Wood-burners Encyclopedia, Crossroads Press, Vermont, 1977) and production figures from World Energy Supplies, 1973-1978, United Nations, New York, 1979.

9. Katoigawa, H., "A Review of Japanese Ocean-Based Solar Energy Conservation Systems," Summaries of Technical Presentations, Vol. 2, pp. 5-10, Japanese-U.S. Symposium on Solar Energy Systems, NSF/RANN, 1974. For 12 ocean currents only.
10. Hubbert, M.K., "Energy Resources" in Resources and Man, by the Committee on Resources and Man, National Academy of Sciences, National Research Council, M.H. Freeman, San Francisco, 1969.
11. McGraw-Hill Encyclopedia of Energy, D.N. Lapedes, Editor-in-Chief, McGraw-Hill, New York, 1976.
12. This is not all used as an energy source; it includes hydrogen used in petrochemical processes, ammonia production, methanol production, and specialty gas uses, such as in steel fabrication, etc.
13. Hubbert, M.K., in A National Fuels and Energy Policy Study, U.S. 93rd Congress, 2nd Session, Senate Committee on Interior and Insular Affairs, Sec. No. 93-40 (95-75), 1974.
14. This is how much electricity is available by converting the uranium in light water reactors; not the total energy content of the uranium. This figure would be near 78,000 trillion Kwh for economically (\$30/lb) recoverable uranium.
15. Gustavson, M.R., Dimension of World Energy, The Mitre Corporation, McLean, Virginia. The estimates for small-scale hydro reserves are included in the large-scale figure.
16. Bammel, J., and T. Heidav, "Geothermal Energy for the Future," *Geothermal Energy*, Dec. 1974. The potential geothermal energy is approximately 7500 Mw/yr/Km² of Earth's surface, down to 7.5 Km below the surface.
17. This estimate includes the 20,000 trillion Kwh from the Data Sheet calculations on potential solar energy for the countries and approximately 50,000 trillion Kwh estimated from similar calculations for the oceans and Antarctica. (Total area data, *The World Almanac and Book of Facts-1978*, G. DeLury [ed.], Newspaper Enterprise Assn., Inc., New York, 1978; and insolation data, Hidore, J., *Physical Geography: Earth Sciences*, Scott, Foresman and Co., Glenview, Ill., 1974).
18. Gustavson, M.R., "Limits to Wind Power Utilization," *Science*, Apr. 6, 1979, pp. 13-17.
19. Total non-fossil carbon production per year for the world.
20. 50,000 thunderstorms/day; 100 thunderbolts/second; 3 million Kw/thunderbolt = 9,459 trillion Kwh/yr.
21. "Worldwide oil and gas at a glance," *Oil and Gas Journal*, Dec. 31, 1979.
22. Linden, H.R., and J.D., Parent, Analysis of World Energy Supplies, Institute of Gas Technology, Chicago, 1975.
23. See data and references for potential geothermal energy on the Data Sheet.
24. See data and references for potential wind energy on the Data Sheet.
25. See data and references for potential biomass energy on the Data Sheet.
26. See data and references for potential tidal energy on the Data Sheet.
27. Assuming 35% recovery proved world reserves of 641.9 billion barrels.
28. Assuming 35% recovery proved world reserves of 270 billion barrels.
29. Assuming 35% recovery proved world reserves of 2570 trillion cubic feet.
30. Figure from McGraw-Hill Encyclopedia of Energy, D.N. Lapedes, Editor-in-Chief, McGraw-Hill, New York, 1976, but only includes land-based generators.
31. Assuming an 80% collection efficiency of manures and residues and a 60% conversion efficiency to biogas, an anaerobic digester using temperatures of about 37°C (readily obtainable in developing nations) has such a conversion efficiency.
32. Assuming a 90% conversion efficiency of proved reserves. The tidal power plant at La Rance, France, has been operating at 91% efficiency for a number of years.
33. The life expectancy of fossil fuel supplies were estimated by subtracting present production from proved reserves. A 4% growth rate in oil and gas production and a 7% growth rate in coal production, all within projected use rates, were assumed. A 2% growth rate in coal and gas proved reserves and a 1% growth rate in oil proved reserves were assumed. The discovery rates lead to total recovery rates on the order of 35% of ultimately recoverable reserves, the maximum that will probably ever be removed from the ground.
34. Based on Lorentz, E., The Nature and Theory of the General Circulation of the Atmosphere, World Meteorological Organization, Geneva, Sept. 1967; if 161 is just land area and land area of world is one-fourth of world, total world including oceans is 640 billion Kwh/yr.
35. Based on 100,000 2.5 MW wind turbines per year for 10 years operating 70% of the time and 1 million 6 Kw wind turbines per year for 10 years operating 50% of the time.
36. Based on 100,000 2.5 MW wind turbines per year for 25 years operating 70% of the time and 1 million 6 Kw wind turbines per year for 25 years operating 50% of the time.
37. Based on 100,000 2.5 MW wind turbines per year for 50 years operating 70% of the time and 1 million 6 Kw wind turbines per year for 50 years operating 50% of the time (in "Energy Ideas," No. 11, National Recreation and Park Assn., Mar. 1978.)
38. Fifty to two hundred MW estimated for laser fusion; 500 to 2,000 MW estimated for a tokamak.
39. U.S. Dept. of the Interior, "Energy Perspectives," a presentation of major energy-related data by Enzer, Dupree, and Miller, U.S. Government Printing Office, Washington, D.C., Feb. 1975.
40. Ibid., three years minimum for Gulf of Mexico wells, twelve years maximum for Gulf of Alaska wells.
41. Lovins, A.B., *Soft Energy Paths: Toward a Durable Peace*, Ballinger Publishing, Cambridge, Mass., 1977.
42. "Tidal Power May Now Make Sense," *Business Week*, Nov. 9, 1974, p. 115.
43. Bethe, H.A., "The Necessity for Fission Power," *Scientific American*, Vol. 234, no. 1, Jan. 1976.
44. Metz, W.D., "Solar Thermal Energy: Bringing the Pieces Together," *Science*, Aug. 12, 1977, p. 650; this figure assumes mass production; at \$20 per Kw, it is about the cost of an automobile engine.
45. Bergey, K.H., "Wind Power Potential to the U.S.," *Aware Magazine*, Oct. 1971, p. 1. Elbridge of Mitre Corporation estimates that mass production costs of wind energy system will be \$100 to \$1,000 per installed Kw for small system (1 to 10 Kw) and \$600 to \$1,000 for large systems.
46. Central Electricity Generating Board in Great Britain.
47. *Science*, Dec. 5, 1977.
48. This estimate does not include various hidden costs. The delivered cost is doubled if the tax and government support is accounted for (tax subsidies, governmental research, and Nuclear Regulatory Commission support are among the hidden costs, paid by increased taxes for the consumer). In addition, the cost of dismantling nuclear plants, which tends to be larger than the original construction costs are not accounted for in the delivered energy cost. The environmental costs are barely understood, much less measured and accounted for.
49. Japanese estimate for their 2 MW wave power facility under development. *The Renewable Energy Handbook*, Energy Probe, University of Toronto, Ontario, Canada.
50. Wade, N., "Windmills: The Resurrection of an Ancient Energy Technology," *Science*, June 7, 1974, pp. 1055-58.
51. Based on oil shale cost per barrel of \$15-\$50.
52. Hammond, A.L., "Photosynthetic Solar Energy: Rediscovering Biomass Fuels," *Science*, Aug. 19, 1977.
53. Ibid., Energy Plantations: \$2.10/million BTU; Agriculture Residues: \$3.00/million BTU; and Marine Energy Plantation: \$4.20/million BTU.

For a more thorough discussion of the various issues, assumptions and facts mentioned in the above notes and references, see *Energy, Earth and Everyone*.

The *World Energy Data Sheet* and *World Energy Atlas* were compiled by the World Resources Inventory—a non profit research and education organization engaged in the collection, analysis, mapping and dissemination of the vital statistics of planet Earth. It is located at 3501 Market St., Philadelphia, Pennsylvania 19104 USA. 215-387-5400.

This *Energy Data Sheet* and its companion—the *World Food System Data Sheet*—attempt to present in one place, in a highly visible format, a comprehensive, whole systems portrait of our global energy and food situations. Both Data Sheets present the most up-to-date information available for the whole world. Each, hopefully, helps to demystify the almost mythically exaggerated complexity of these two most vital life support systems on Earth. Each Data Sheet presents the “whole system” thereby allowing meaningful comparison and a working knowledge of the role the part plays in the whole. Each presents the vital geographical dimension of these problem areas. Specific quantities are furnished where before, at best, we had only vague guesses from random points around the world.

The World Energy Data Sheet is a base from which further, more refined, studies of renewable energy availability can be made, as well as a means for helping to determine the overall use and availability of a wide variety of energy sources in a specific country or region. Data has been drawn from a wide variety of sources. All maps and charts are updated and revised from *Energy, Earth & Everyone* by Medard Gabel (Anchor Press/Doubleday 1980). Explanatory notes and detailed references for each category are to be found in the *World Energy Data Sheet Reference Guide* which accompanies the Data Sheet. Research for the World Energy Data Sheet and Atlas was done by Seth Snyder.

Further copies of the *World Energy Data Sheet* can be obtained for \$3.00 plus .50 postage and handling from the World Resources Inventory, 3501 Market St., Phila., PA 19104 USA. Copies of the *World Food System Data Sheet and Atlas* are available for \$1.50 plus .50 postage and handling. Bulk purchase orders should inquire for discount prices.

Countries of the World	1977																																
	1977																																
	1977																																
WORLD	4,414	13,395,241	75,929	71,233	16,876	260	35,708	46,335	34,582	32,571	30,731	8,567	22,651	22,803	14,105	14,124	630,675	1,829,026	7,627	5,528	1,558	531	10	20,022	22,280	161,246	20,580	1,967	37,331	1,007	2,405	52,42	
AFRICA	472.0	3,031,168	4,468.9	1,455.1	3,360.8	101.8	3,420.1	922.8	647.0	629.3	611.7	131.8	763.0	690.6	219.3	73.8	183,130	36,776	154.9	105.2	49.7				6,670.4	6,609.1	41,337.6	1,735.3	483.7	4,817.1		309.5	4,882
Algeria	19.0	238,174	806.8	103.6	5,597.3	136.5	645.8	69.3	55.3	55.6	48.5	10.5		1.8	153.5	49.8		1,200	4.7	4.2	0.5				434.8	555.6	3,752.6	34.3	2.1	49.7		3.6	0.116
Angola	6.7	124,670	99.8	10.7	1,566.8	97.9	98.1	20.9	11.2	11.1	8.6	0.8			0.8	0.8		523	1.3	0.4	1.0				292.3	25.4	934.3	24.5	11.2	430.2		5.1	0.056
Benin	3.6	11,262		1.5	454.5	16.8					1.4							15							26.4	22.9	144.6	14.4	3.7	5.6		1.4	0.047
Botswana	0.8	60,037																							99.2	119.7	714.6	13.8				4.0	0.011
Burundi	4.5	2,783	0.1	0.4	95.7	3.8					0.3		0.1	0.1				7							7.5	5.9	17.9	11.0	1.5			1.3	0.060
Cameroun	8.5	47,544	1.3	6.6	968.8	35.9					5.0							346	1.4	0.1	1.3				127.9	90.7	335.9	28.8	10.8	16.4		5.0	0.098
Cape Verde	0.3	403		0.4	1,160.1	25.8					0.4							6							0.3	0.9	14.2	0.2		37.4			0.003
Cent. Afr. Rep.	2.2	62,298	0.1	0.7	358.8	19.9					0.6							17	0.1		0.1				189.2	126.8	200.1	5.6	3.1			1.0	0.032
Chad	4.5	128,400		0.8	179.4	10.0					0.7							23	0.1	0.1					389.9	299.5	659.8	28.3	5.5			7.3	0.049
Comoros	0.3	217		0.1	418.6	9.7					0.1							1							0.4	0.5	5.6	0.8		12.8		0.1	0.004
Congo	1.6	34,200	19.3	1.6	1,423.2	52.7	19.1				1.4							34	0.1	0.1	0.1				92.0	59.5	241.7	1.7	3.1	46.8		0.1	0.015
Egypt	42.1	100,145	277.8	149.2	3,767.4	85.6	252.4	132.8	125.3	129.5	113.3	20.0		10.3	11.4	11.4		3,944	13.5	4.3	9.2				252.2	212.4	1,929.4	93.5	0.2	104.6		10.0	0.322
Eq. Guinea	0.4	2,805		0.3	861.1	30.8					0.3							7							7.1	4.2	36.0	0.2	0.7	15.3			0.003
Ethiopia	32.6	122,190	0.4	4.7	155.5	7.1		8.9	6.9	6.8	4.2	1.0						320	0.7	0.3	0.4				286.5	269.5	1,883.2	218.8	38.4	45.5		55.4	0.383
Gabon	0.6	26,767	138.3	8.0	14,902.2	709.6	136.3	30.3	18.5	18.5	5.8	1.8				2.0	2.0		90	0.5	0.5				67.4	39.7	343.8	0.6	1.9	221.7			0.008
Gambia	0.6	1,130		0.5	873.1	41.6					0.5							8							1.5	2.6	36.3	2.1	0.4	3.2		0.5	0.008
Ghana	11.7	23,854	4.5	14.5	1,339.5	34.4	0.2	17.3	14.1	14.1	9.8	3.0		0.1				900	4.3	0.1	4.3				47.7	48.6	306.4	18.3	17.0	23.8		1.4	0.120
Guinea	5.0	24,586	0.1	3.5	741.5	37.1					3.3							175	0.5	0.4	0.1				33.4	53.2	505.3	16.0	4.5	15.8		2.6	0.065
Guinea Bissau	0.6	3,612		0.4	502.3	35.9					0.3							8							4.7	8.1	95.9	2.3	0.7	17.9		0.4	0.005
Ivory Coast	8.0	32,246	0.3	15.4	2,906.3	100.2		23.3	19.3	19.3	14.5	3.4						502	1.3	1.0	0.3				53.3	68.4	455.7	15.2	8.4	22.8		1.1	0.111
Kenya	15.9	58,264	0.8	16.8	1,136.2	29.1		56.8	30.7	30.3	14.6	5.0		0.6				356	1.1	0.4	0.8				156.8	138.4	748.5	66.3	23.0	23.5		12.9	0.169
Lesotho	1.3	3,035																							2.9	6.4	59.8	6.9				1.2	0.020
Liberia	1.9	11,137	0.3	5.9	3,217.2	123.7		9.0	6.4	6.4	5.4	0.9						300	0.9	0.6	0.3				18.4	24.1	382.5	4.0	3.0	24.2		0.1	0.019
Libya	3.0	175,954	1,185.2	38.1	15,368.6	357.4	1,139.8	77.7	59.4	55.9	36.3	7.7			41.7			800	1.6	1.6					473.4	380.6	3,164.3	7.5	0.8	75.8		0.5	0.020
Madagascar	8.7	58,704	0.2	5.6	633.9	15.5		9.0	6.3	6.1	4.9	1.3		0.2				95	0.4	0.2	0.2				86.9	12.0	1,884.9	71.5	8.1	1,815.9		16.0	0.131
Malawi	6.1	11,848	0.3	2.3	418.6	14.0					1.4			0.6				116	0.3		0.3				23.7	26.6	167.4	16.1	4.9			1.2	0.072
Mali	6.6	124,000	0.1	1.5	251.2	17.9					1.4							43	0.1	0.1					204.9	284.0	1,412.2	36.9	4.8			7.9	0.101
Mauritania	1.6	103,070		2.3	1,650.5	91.7					2.1			0.1				40	0.1	0.1					152.6	240.4	2,051.9	13.4	0.9	30.0		3.7	0.014
Mauritius	0.9	186	0.1	3.0	3,312.9	46.0					2.8							155	0.4	0.4	0.1				0.2	0.4	6.6	0.7	0.1	9.8		0.1	0.010
Morocco	21.0	44,655	8.3	44.5	2,320.2	58.0	0.2	46.6	33.6	32.0	35.3	5.1		5.9	5.6	0.8	0.8	980	3.7	2.3	1.4				58.4	77.7	1,347.9	63.7	4.9	98.0		9.4	0.150
Mozambique	10.3	78,303	10.8	12.2	1,231.9	45.6		9.6	4.6	4.4	5.6	0.8		4.1	5.7			1,397	7.2	0.5	6.8				115.9	169.4	1,710.2	17.2	13.3	1,139.3		2.2	0.116
Namibia	1.0	82,429																							136.3	178.3	1,228.0	20.5		67.8		4.9	0.009
Niger	5.5	126,700		1.6	311.0	22.1					1.5			2.2	2.1	5.8	5.8	20							319.0	30.1	651.0	34.8	4.4			6.1	0.047
Nigeria	77.1	92,377	1,075.1	59.4	861.1	31.9	1,064.4	35.9	28.7	28.0	46.1	9.6						960	3.5	0.9	2.6				232.6	184.1	783.2	190.7	103.9	34.8		20.4	0.795
Reunion	0.5	252	0.1	3.0	6,099.6	84.7					2.7							100	0.3	0.1	0.1				0.2	0.5	8.9	0.6	0.1	9.3			0.005
Rwanda	5.1	2,634	0.2	0.7	143.5	5.3					0.5							38	0.2		0.2				7.1	5.6	16.9	10.5	6.3			1.1	0.070
Senegal	5.7	19,619		7.0	1,471.1	70.1		10.8	9.4	9.4	6.7	2.0						130	0.5	0.5					25.6	44.9	621.6	20.3	5.6	20.1		4.7	0.068
Sierra Leone	3.5	7,174		2.6	813.3	29.1		8.4	4.3	3.7	2.5	0.6						95	0.2	0.2					9.4	15.2	184.3	7.6	4.0	18.3		0.5	0.034
Somalia	3.6	63,766		2.8	801.3	42.2		6.0	1.1	1.1	2.7	0.3						18	0.1	0.1					149.5	146.0	1,556.0	26.2	5.5	97.8		7.7	0.040
South Africa	28.4	122,104	725.8	784.6	25,857.5	487.9		263.1	152.0	144.5	134.9	46.4		723.6	635.0			17,655	84.9	82.8	2.1				117.3	253.7	2,373.9	184.5	3.5	133.0		21.6	0.297
Sudan	18.7	250,581	0.5	23.6	1,399.3	41.2		15.6	15.2	14.7	22.3	1.9						220	0.9	0.4	0.5				674.3	584.4	3,380.1	120.0	43.3	32.2		31.7	0.156
Swaziland	0.6	1,736																							1.7	3.7	44.6	4.3				1.1	0.007
Tanzania	18.6	94,509	0.5	8.8	526.2	17.5		10.2	7.7	7.7	7.9	1.4						180	0.7	0.5	0.2				221.6	204.4	1,031.9	101.6	61.2	57.2		24.5	0.210
Togo	2.5	5,600		1.9	777.4	32.4		12.0	10.8	10.8	1.7	3.4						24	0.1	0.1					12.2	11.2	71.9	6.2	1.5	2.3		0.4	0.031
Tunisia	6.5	16,361	54.4	26.9	4,413.2	95.9	51.2	14.4	13.8	13.1	21.9	1.9			0.9	3.1	3.1	532	1.7	1.7					32.7	29.8	420.3	14.7	2.9	46.3		2.4	0.045
Uganda	13.7	23,604	0.7	5.0	394.7	9.9					4.3							163	0.7		0.7				63.5	49.1	288.1	50.2	22.0			8.0	0.156
Upper Volta	6.9	27,420		1.3	203.3	12.7					1.2							20	0.1	0.1					54.8	61.6	352.2	22.6	6.3			3.5	0.097
Zaire	29.3	234,541	18.8	15.6	562.1	17.6	13.7	10.2	2.4	2.4	8.9	0.6		1.1	2.3			1,217	4.1	0.1	4.0				631.1	417.8	903.8	34.6	19.1	12.0		1.9	0.341
Zambia	5.8	75,261	14.3	21.1	3,851.1	101.4		13.2	10.2	10.1	8.5	2.6		5.8	6.2		</																

SOUTH AMERICA

	239.0	1,781,980	2,580.0	1,887.7	8,067.2	115.3
Argentina	27.1	276,689	368.0	402.1	15,237.0	179.3
Bolivia	5.3	109,858	39.9	18.3	2,990.0	76.7
Brazil	122.0	851,197	250.0	745.8	6,458.0	97.9
Chile	11.3	75,695	46.9	88.1	8,108.9	102.6
Colombia	26.7	113,891	151.7	147.4	5,693.0	79.1
Ecuador	8.0	28,356	119.1	32.1	4,114.2	59.6
Guyana	0.9	21,497		7.1	8,706.9	103.7
Paraguay	3.3	40,675	0.5	4.7	1,626.6	21.7
Peru	17.6	128,522	96.5	88.9	5,286.3	81.3
Surinam	0.4	16,327	1.3	8.1	17,497.5	210.8
Uruguay	2.9	17,751	1.7	24.6	8,575.3	99.7
Venezuela	13.9	91,205	1,504.5	319.1	24,314.7	307.8

ASIA

	2,563.0	2,757,442	229,872.9	14,093.3	5,641.8	97.3
Afghanistan	15.9	64,750	29.8	6.9	382.7	22.5
Bangladesh	90.6	14,400	11.4	29.3	346.8	10.8
Bhutan	1.3	4,700				
Burma	34.4	67,655	20.2	16.7	514.3	10.3
China	975.0	959,696	6,392.9	6,234.9	6,805.2	95.9
Cyprus	0.6	925		9.9	16,002.5	188.3
East Timor	0.8	1,493		0.1	119.6	
Hong Kong	4.8	104		62.1	13,478.9	154.9
India	676.2	328,759	786.2	924.1	1,447.2	35.3
Indonesia	144.3	190,435	1,142.8	332.2	2,260.4	47.1
Iran	38.5	164,800	3,481.7	517.9	14,710.8	282.9
Iraq	13.2	43,492	1,560.3	63.5	5,142.8	114.3
Israel	3.9	2,077	0.9	70.9	19,219.7	216.0
Japan	116.8	37,231	301.4	3,575.5	31,119.9	324.2
Jordan	3.2	9,774		12.9	4,353.4	92.6
Kampuchea DM	6.0	18,104		0.3	23.9	0.6
Korea DPR	17.9	12,054	360.4	375.2	21,982.5	293.1
Korea Rep	38.2	9,848	149.1	409.4	11,063.0	134.9
Kuwait	1.3	1,782	1,327.0	66.0	55,087.8	734.5
Lao PDR	3.7	23,680	0.3	1.7	490.4	18.9
Lebanon	3.2	1,040	0.8	24.0	7,618.5	96.4
Malaysia	14.0	32,975	117.9	76.9	5,824.5	79.8
Mongolia	1.7	156,500	10.4	15.9	10,082.3	129.3
Nepal	14.0	14,080	0.1	1.2	83.7	3.1
Oman	0.9	21,246	187.9	13.8	16,313.4	
Pakistan	86.5	80,394	70.0	107.5	1,399.3	38.9
Philippines	47.7	30,000	7.2	127.9	2,762.8	38.9
Saudi Arabia	8.2	214,969	5,023.8	104.3	10,620.5	366.2
Singapore	2.4	58		46.7	20,021.0	232.8
Sri Lanka	14.8	6,561	1.3	13.2	885.0	10.8
Syria	8.6	18,518	127.3	63.7	7,881.6	151.6
Thailand	47.3	51,400	6.0	119.9	2,095.1	37.4
Turkey	45.5	78,058	97.1	278.7	6,446.4	115.1
Vietnam	53.3	32,956	49.5	50.0	1,016.6	19.6
Yemen AR	5.6	19,500		3.1	430.6	16.0
Yemen Dem.	1.9	33,297		7.7	4,257.8	133.1

USSR

	266.0	2,240,220	15,086.1	11,760.2	44,754.3	520.4
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EUROPE

	484.0	487,032	9,999.7	17,631.2	36,503.5	392.5
Albania	2.7	2,875	41.6	21.8	8,120.8	106.9
Austria	7.5	8,385	83.8	247.3	32,937.8	354.2
Belgium Luxem	10.3	3,310	67.8	529.2	51,879.4	603.3
Bulgaria	8.9	11,091	114.7	360.0	40,843.4	444.0
Czechoslovakia	15.4	12,788	675.6	927.6	61,271.1	658.8
Denmark	5.1	4,307	4.5	225.2	44,120.4	459.6
Finland	4.8	33,701	18.1	201.3	42,350.4	450.5
France	53.6	54,703	378.1	1,893.3	35,533.2	374.0
German DR	16.7	10,818	679.1	970.8	57,934.2	616.3
Germany, FR	61.1	24,858	1,342.7	3,000.3	48,940.3	520.6
Greece	9.6	13,194	36.8	147.2	15,667.6	176.0
Hungary	10.8	9,303	174.2	300.0	28,082.1	312.0
Iceland	0.2	10,300	2.6	6.5	39,420.2	423.9
Ireland	3.3	7,028	20.9	86.5	26,778.4	287.9
Italy	57.2	30,123	205.9	1,490.1	26,276.1	285.6
Malta	0.3	32		3.0	8,802.6	101.2
Netherlands	14.1	3,695	799.6	604.0	43,343.0	451.5
Norway	4.1	32,422	419.6	184.0	45,328.4	467.3
Poland	35.5	31,268	1,740.4	1,593.4	45,519.8	494.8
Portugal	9.9	9,208	11.1	82.1	8,384.0	104.8
Romania	22.3	23,750	657.6	713.6	32,878.0	361.3
Spain	37.8	50,478	189.3	718.7	19,566.6	212.7
Sweden	8.3	44,996	72.6	401.0	48,438.0	499.4
Switzerland	6.3	4,129	41.7	190.3	30,019.6	316.0
United Kingdom	55.8	24,482	1,996.1	2,367.1	42,410.2	451.2
Yugoslavia	22.4	25,580	226.3	362.8	16,552.6	197.1

OCEANIA

	23.0	850,956	1,090.5	893.6	40,281.3	468.4
Australia	14.6	768,685	1,035.0	767.7	53,879.8	573.2
Fiji	0.6	1,827		2.3	3,791.3	48.0
New Zealand	3.2	26,828	54.9	95.8	30,844.8	328.1
Papua-N. Guin.	3.2	46,169	0.3	7.1	2,368.1	56.4

Total Energy Supply and Use

Petroleum Supplies

Other Depletable Energy Supplies

Electricity Production

Renewable Energy Resources

	1,989.3	2,417.5	1,803.0	1,703.3	1,236.1	465.4
271.5	397.1	284.8	265.4	267.2	59.3	
20.9	23.1	14.9	15.1	15.0	6.8	
96.3	687.7	590.4	545.4	533.9	135.2	
10.1	71.8	55.4	58.6	57.3	14.4	
81.3	103.7	92.6	87.6	75.2	28.6	
117.7	41.9	37.9	37.6	29.1	8.7	
	6.0	2.7	2.6	4.1	0.9	
83.7	108.4	73.4	72.5	71.6	19.5	
				6.4		
	29.3	21.7	21.2	21.8	2.9	
1,307.9	959.4	617.9	597.3	146.3	79.8	

	15,268.8	8,877.1	6,826.4	6,659.3	5,886.7	819.7
4.4						
20.1	14.2	13.0	14.2		0.7	
17.5	15.8	12.3	11.7	11.7	3.2	
1,244.4	980.7	964.1	1,071.7	1,056.4		
9.0	5.6	5.4		9.5	1.3	
				0.1		
				60.3		
133.8	382.7	278.8	231.8	251.1	19.9	
1,076.4	300.2	271.4	254.6	268.3	32.2	
3,121.6	481.5	430.6	434.6	264.4	71.7	
1,542.8	135.2	65.8	55.4	44.0	8.9	
0.4	131.6	84.8	84.7	67.9	12.4	
6.5	3,470.7	2,607.2	2,535.2	2,549.2	323.9	
	17.2	14.4	13.3	12.3	3.1	
	7.2			0.2		
	23.9	14.2	14.2	14.2	6.6	
	301.2	277.6	243.2	242.6	12.3	
1,258.2	355.2	211.5	198.2	20.0	9.8	
				1.5		
	29.9	25.7	25.7	22.2	6.0	
115.8	101.1	56.8	54.4	65.7	5.6	
	0.8	0.1	0.1	5.3		
187.9				0.9		
				13.4		
5.7	44.3	39.2	36.2	41.0	6.3	
	162.3	115.2	112.7	115.7	23.6	
4,907.5	418.6	346.8	354.1	92.7	21.0	
	549.6	291.9	253.0	44.7	11.8	
	22.1	17.3	15.6	11.4	1.4	
119.7	53.8	45.0	41.1	53.7	7.2	
0.1	101.7	95.4	91.0	109.2	10.1	
29.9	193.2	179.5	168.2	198.2	32.8	
				7.0		
				3.0		
	106.4	21.3	21.3	7.4	1.3	

	6,846.6	5,298.3	4,820.5	4,420.9	3,957.1	
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	1,261.0	13,738.8	8,859.6	8,062.3	7,822.4	2,455.2
33.5	38.3	32.7	13.4	13.3	2.4	
21.5	171.0	104.6	97.6	120.6	19.5	
	669.2	420.4	389.0	256.2	81.9	
1.4	143.5	137.5	129.0	152.0	22.5	
1.4	221.3	205.5	186.5	192.6	21.8	
4.5	134.3	91.2	86.6	177.4	18.3	
	179.4	123.6	112.6	133.6	24.9	
22.3	2,066.7	1,376.9	1,249.2	1,145.2	242.4	
0.6	241.6	236.0	216.3	189.5	42.4	
60.4	1,889.7	1,198.1	1,074.5	1,421.2	247.6	
	154.3	126.4	116.3	102.4	13.1	
27.0	123.2	120.5	101.8	110.5	15.1	
				6.0		
	35.5	26.4	26.1	57.7	5.9	
16.5	2,607.3	1,288.7	1,196.1	1,017.0	211.6	
				2.9		
16.8	1,233.4	683.0	600.7	221.9	89.6	
207.2	153.1	108.4	100.5	94.0	16.6	
3.8	216.5	182.5	162.5	172.1	45.3	
	77.7	68.5	63.8	65.2	10.0	
174.6	303.8	278.1	256.3	177.9	63.3	
10.8	837.2	549.0	502.6	473.8	70.1	
	253.6	176.4	167.6	302.9	30.8	
	81.9	50.5	48.1	139.3	11.1	
610.0	1,710.3	1,103.3	1,010.5	914.3	204.8	
48.8	196.1	171.7	155.2	161.5	31.1	

	257.7	501.4	386.7	381.9	374.0	150.3
250.0	435.4	333.0	308.9	300.2	134.0	
				2.1		
7.8	41.9	36.7	35.4	46.2	16.4	
				6.5		

	79.7	134.7	304.0	301.4	2,865
2.9	12.7	81.4	102.3	2,865	
		17.6	1.4		
34.6	70.7	13.4	13.4		
8.9	13.3	14.9	7.5		
32.5	32.5	24.3	24.3		
		0.6	0.6		
	1.7	5.5	5.5		
	0.2				
0.8	3.3	146.4	146.4		

	6,424.5	6,913.9	842.8	760.5	
1.4	1.4	27.8	0.3		
	3.1	10.9	10.9		
0.1	1.7	1.8	1.8		
5,028.1	5,013.2	53.3	53.3		
	0.1				
595.4	606.1	14.4	14.4		
2.2	2.1	61.8	47.6		
7.3	8.1	321.4	228.4		
		17.4	17.4		
	0.1	0.6	0.6		
154.6	623.6	32.4	186.6		

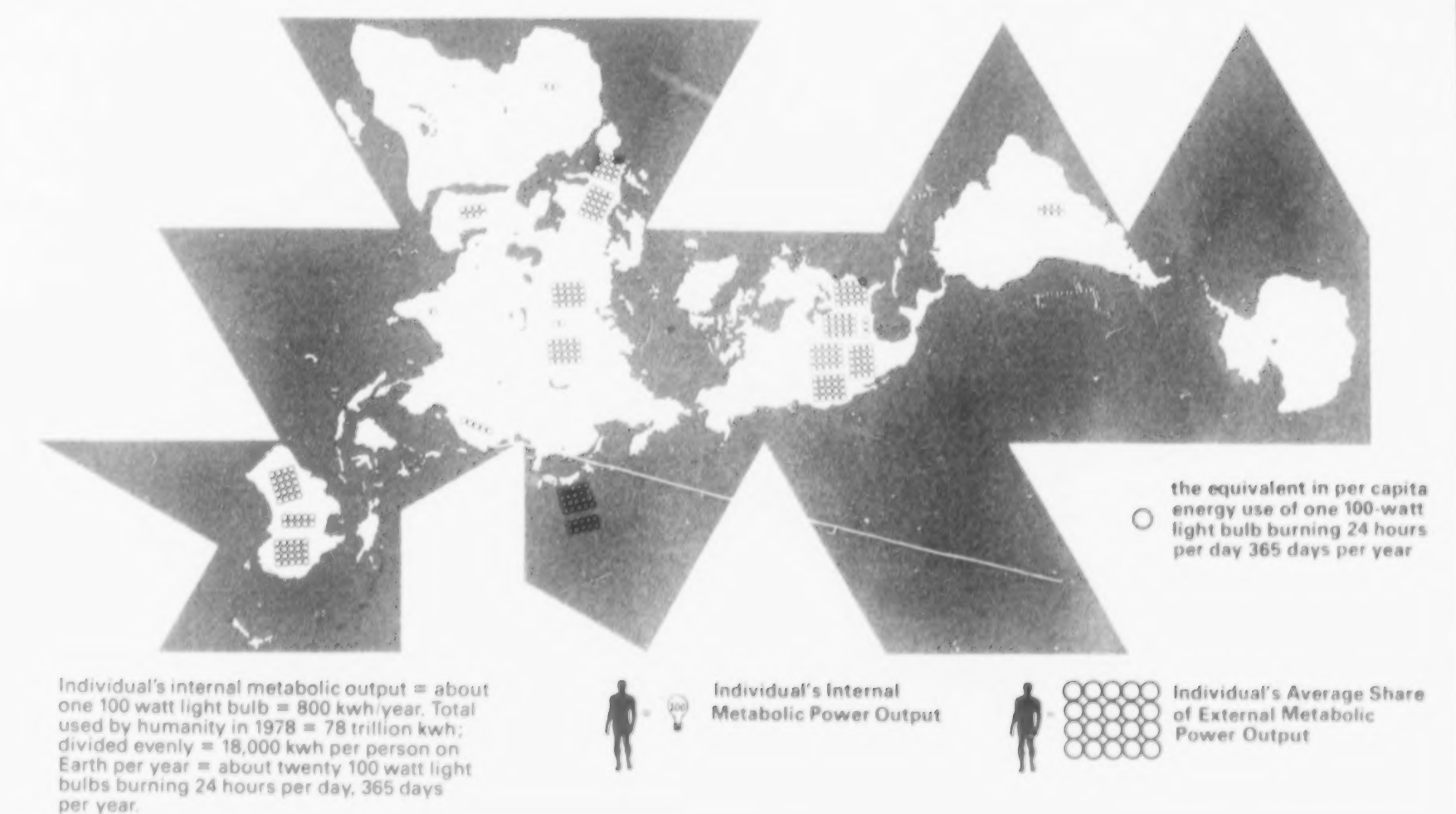
World Energy Atlas

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World Population—1980¹



Per Capita Energy Use—1978²

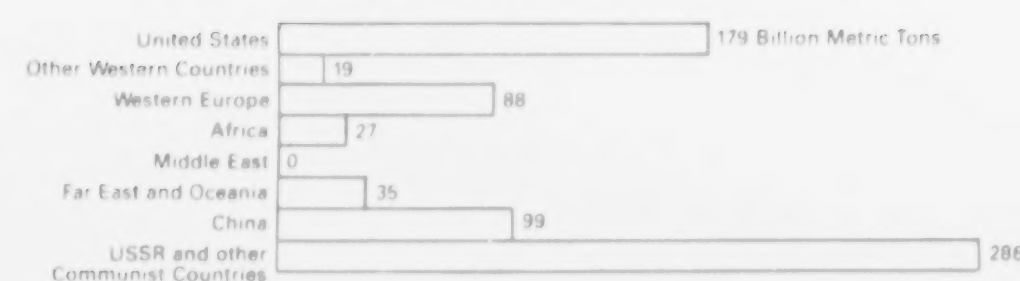


Coal Deposits^{3,4}



World Proven Reserves of Coal, 1977⁵

Total: 733 Billion Metric Tons



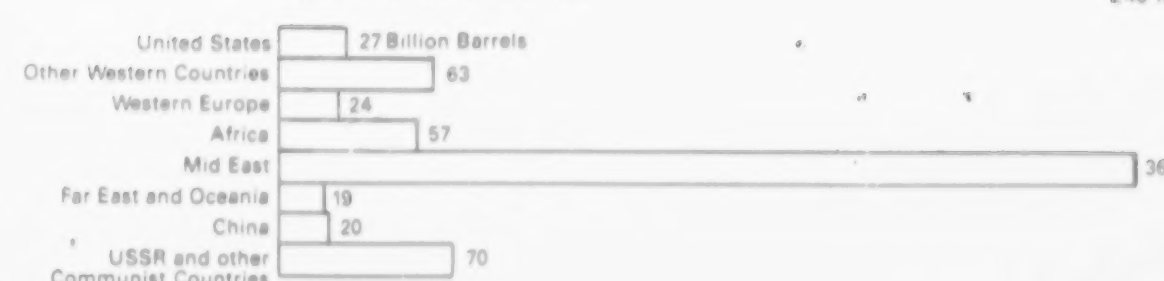
In addition to the above coal deposits sites, there are believed to be major coal deposits offshore, as in the case of oil. Efforts to mine offshore coal require modification of existing systems rather than the invention of new systems.⁶ (Undersea coal mining in northeast England has been going on for over ninety years; to date, over 375 million tons of coal have been mined from this location.)

Petroleum Reserves³



World Proven Crude Oil Reserves, 1979⁷

Total: 642 Billion Barrels



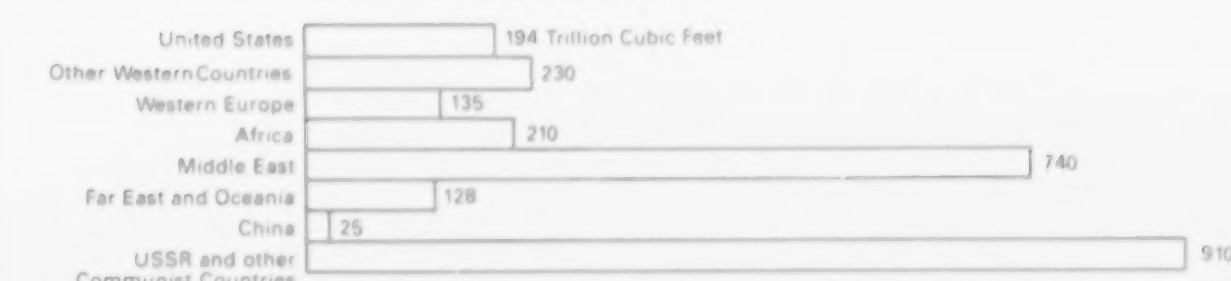
Over 30,000 oil fields have been discovered, but about 75% of the world's oil lies within 240 large fields.⁸

Natural Gas Reserves³



World Proven Natural Gas Reserves, 1979⁹

Total: 2573 Trillion Cubic Feet

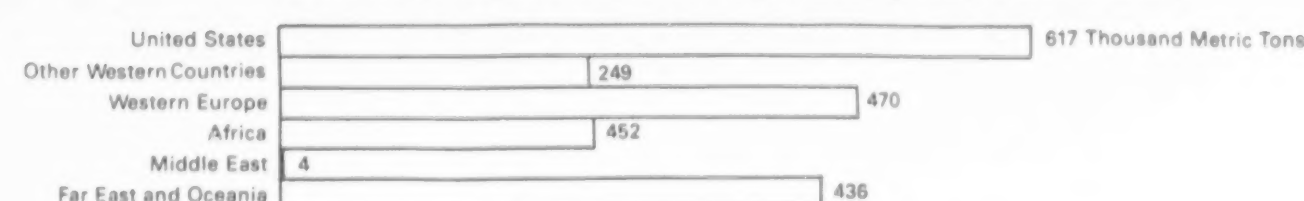


Uranium Resource Locations^{3,8}

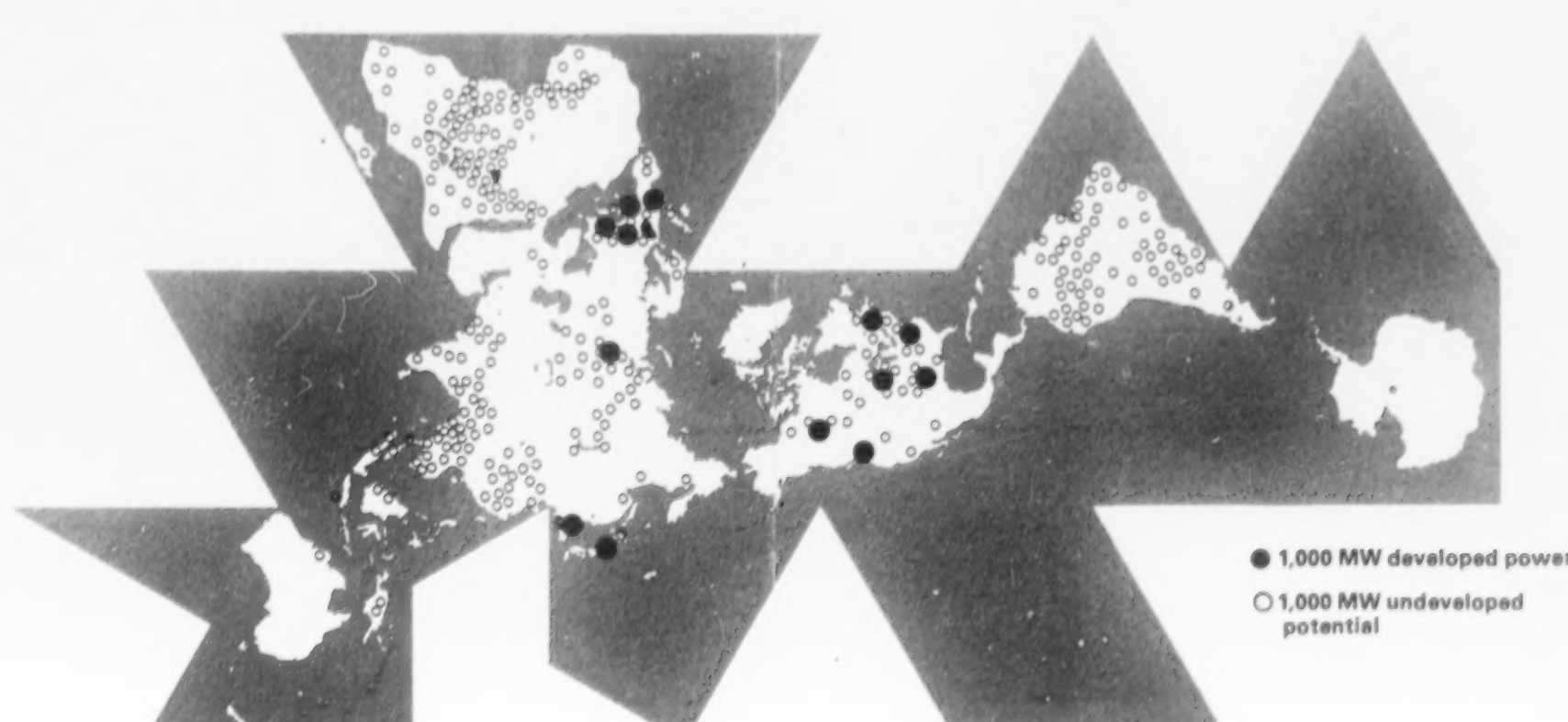


Reasonably Assured Uranium Resources¹⁰ (for \$30/lb U₃O₈)

Total: 2,228 Thousand Metric Tons (not including Eastern Bloc countries)

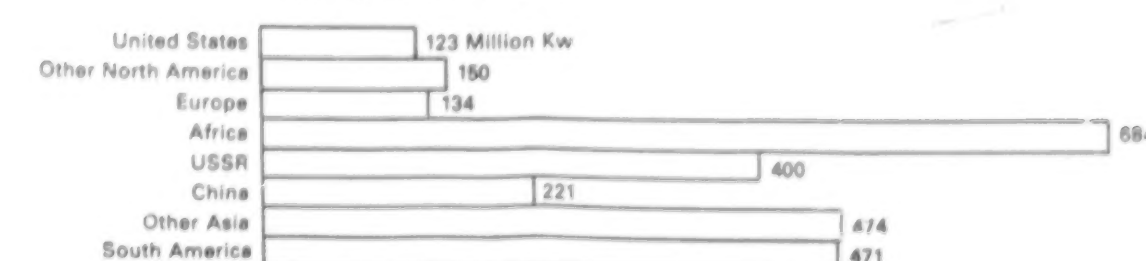


Water Power¹⁰



World Water-Power Potential¹¹

Total: 2,724 Million Kw



Potential and Currently Utilized Geothermal Sites¹²



Three quarters of the geothermal energy now being used by humanity goes into non-electrical uses.¹³

